TABLE 4.1: General morphological characteristics of the Wolkberg Cave

Feature	First Chamber	Second Chamber	Long Passage	Third Chamber	The Rift	Vertical Passage	Boulder Chamber
Form: plan	elongate	elongate	linear	elongate	linear	oval	elongate
Form: cross section	domed	domed	square	domed	canyon	shaft	part dome
Height	15m	20m	10m	30m	30m	60m	25m
Long axis	120m	200m	400m	50m	110m	5m	30m
Short axis	60m	30m	8m	30m	5m	3m	20m
Floor: breakdown	×	×	×	×	×	×	×
Floor: flowstone	×	×	×	×	×		×
Floor: breccia	×	×	×	×	×		
Floor: earth	×		×	×		×	
Water: permanent				×	×		×
Water: temporary		×	×		×		
Roof: bedding plane			×		×		
Roof: dome	×	×		×			×

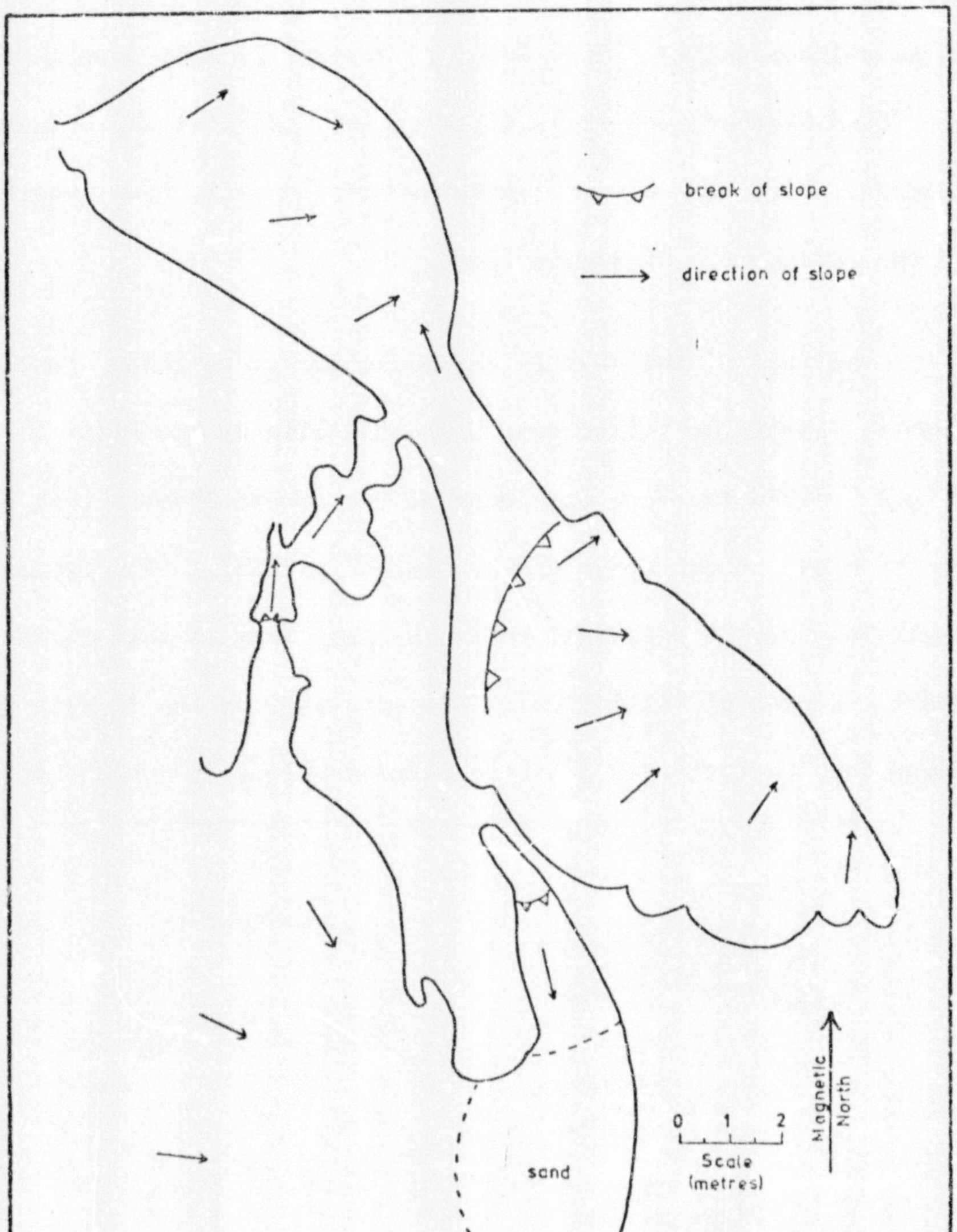

Figure 4.2: Relationship of the First and Second Chambers in the vicinity of the tube.

where these variations occur indicates that they have been controlled by fractures intersecting the general trend of the cave at an oblique angle. Such fracture control is most apparent in the Third Chamber, but it is also true of the First and Second Chambers where the role of fractures has, however, been subordinated by the development of stable domes.

The form of the cave in cross-section is variable, ranging from the partially filled dome characteristic of the First Chamber (Fig.4.3a) and the more open dome of the Second Chamber (Fig.4.3b) to the high, narrow gorge of The Rift (Fig.4.3d). The cross-sectional form is dependent on the primary form of that section and the degree of filling which has occurred, as may be seen by comparing The Rift with the Long Passage (Fig.4.3c) which contains

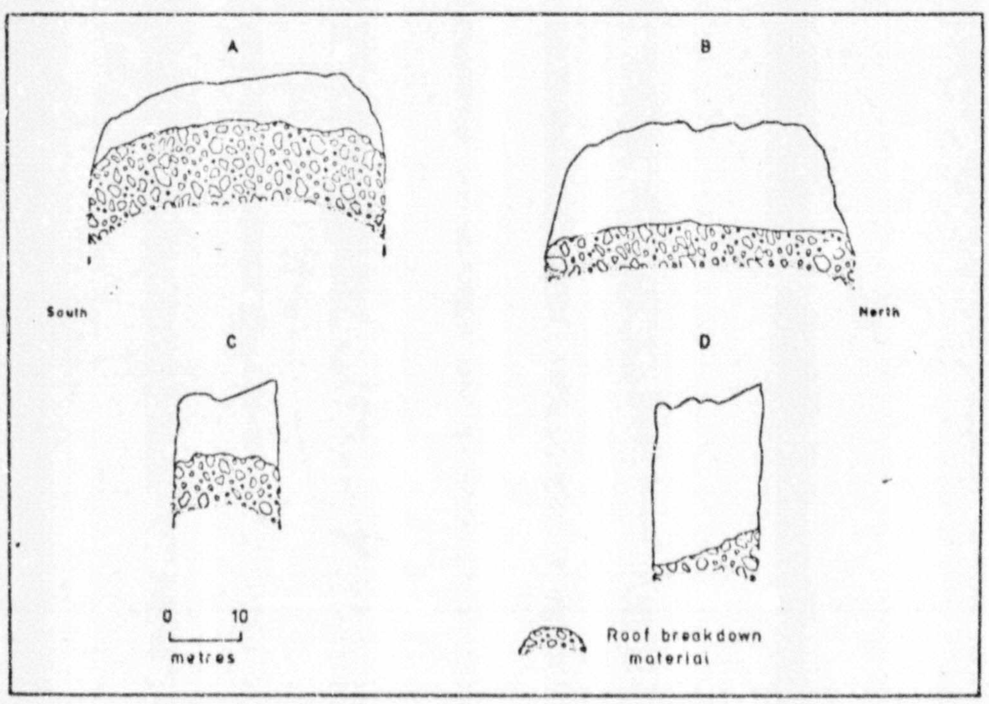

Figure 4.3 Generalized cross-sections

(a) First Chamber
(b) Second Chamber
(c) Long Passage
(d) The Rift

a greater amount of fill, and the Second Chamber with the First, the latter containing a greater volume of fill material of both internal and external origin. The floor shape is controlled in detail by the nature of the fill material, and ranges from smooth continuous flowstone surfaces to irregular surfaced collapse mounds. The ceiling, in cross-section, is commonly a single bed, presenting a planar surface sloping to the south with a dip of 30°, except in the chambers, where domed forms predominate.

GEOLOGIC LOCATION OF THE CAVE

Surface observations indicate that the cave has developed within a portion of the geological succession characterised by 30mm to 50mm bands of chert separated by 100mm bands of dolomite. The entrance lies stratigraphically below a pair of 8m to 10m high escarpments displaying a similar alternation of chert and dolomite. Stratigraphically above these minor escarpments lie exposures of black carbonaceous mudstone which is laterally associated with a chert-in-shale breccia, above which are exposures of limestone.

Underground observations indicate that the cave has developed in a zone of chocolate weathering dolomite which displays frequent intercalations of chert, numerous algal laminations, and stromatolitic domes of 300mm to 400mm in diameter. In the vicinity of the entrance, the influence of larger stromatolitic domes having a diameter of the order of 10m is apparent.

The above observations indicate that the cave has developed within the Upper Dolomite and Chert Zone (Button, 1974), which is characterised by the occurrence of 'bread and butter' dolomite, domed stromatolites of 100mm to 1m in diameter, and large domes of up to 10m in diameter. Furthermore, the occurrence of black carbonaceous mudstone associated with a chert-in-shale breccia, above which lies limestone, is indicative of the base of the Mixed Zone. It is therefore concluded that the Wolkberg Cave has developed close to the top of the Upper Dolomite and Chert Zone.

The system is located on the southern limb of an anticline plunging gently to the west, and the structural analysis has not indicated the surface expression of any feature which may affect the cave (Fig. 3.5).

GEOLOGY WITHIN THE CAVE

Exposures of the Malmani Dolomite within the cave are typically of dolomite beds ranging between 100mm and 1m in thickness, with interbedded chert bands of approximately 50mm in thickness. The wall rock, particularly in the Long Passage, frequently has a well weathered surface, commonly displaying rounded corners and being chocolate brown in colour. The chert bands are often prominent due to the removal of the more soluble dolomite from between the bands, and are extremely brittle. In all exposures measured, the rock strikes at 285° to 287° with dips ranging between 25° and 35° to the south.

The dolomite is frequently well fractured, displaying traces of a number of joint sets and small scale faults. The azimuths of joint sets measured in exposures in the Long Passage are 295°, 025°, and 045°, the 295° set frequently being dominant. Throughout the length of The Rift and the Long Passage, the ceiling is etched by a corroded fracture which has an azimuth of 300° to 302°, and which in some places contains a fill of jumbled dolomite and chert fragments. At one site in the Long Passage, this fracture may be seen to be a vertical plane which is paralleled by a small splinter fault (Fig.4.4). Furthermore, the southern wall of The Rift is planar in gross detail, and the exposed chert bands all display a smoothed planar face parallel to the wall, implying that the rock has been subjected to a vertical shear stress. The fracture is also exposed above the sump in The Rift, and has been reported as occurring on the far side of the sump.[1]

A zone of intensely shattered rock is exposed in the walls of the First Chamber in the vicinity of the entrance.

A detailed surface examination has revealed that this zone is not continuous to the surface, although it may be traced downwards within the Vertical Passage for a depth of 30m. It was also noted during this surface examination that an elliptical body of breccia 10m by 20m is exposed to the west of the entrance, and that this

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1. Krynski, J., pers. comm.

breccia consists of cemented surface materials which have occupied a depression.

COLLAPSE FEATURES

Collapse modification of the primary solutional form of the system has occurred in most parts of the cave, as is evidenced by the large amount of block breakdown which occurs throughout. The results of such modification may frequently be observed in the form of the ceiling and in the plan of both the chambers and the linking passages. Bedding plane control of the ceilings occurs commonly throughout the Long Passage and The Rift where the entire ceiling width of up to 10m may be a single chert band. The influence of a single bedding plane is not as pronounced in the large chambers since the form has tended towards a stable dome configuration, but the influence may be seen to have controlled the ceiling of the Second Chamber in detail. An unusual occurrence may be noted close to the entrance of the cave where the influence of large domed stromatolites has resulted in the curving of bedding planes, and has controlled the breakdown such that the ceiling is there 15m higher than the general ceiling level.

Modification of the cave in plan by collapse is general throughout the cave. The walls of the Third Chamber are controlled by fractures aligned at approximately 035° and 290°. The marked enlargement of The Rift close to the sump has also been controlled by collapse along fractures, and similar influences may be observed

Figure 4.4: Splinter fault in the Long Passage
(displacement approximately 200mm)

200m east of the start of the Long Passage. A noticeable extension north of the tube leading into the Second Chamber is the result of the subsidence of a 20m by 20m block, leaving a cavity between the bedding planes 1,5m high. A further influence of collapse is the development of twinned passages in the central portion of the Long Passage due to the rotation of large collapse blocks, the axis of rotation being at the foot of the fracture.

WATER BODIES

Both permanent and temporary water bodies occur within the cave (Table 4.1). The largest permanent water body in the cave occurs in the Boulder Chamber, covering a known area of 50m by 15m and the level of the surface of this pool has been reported as fluctuating through a range of 15m.[1] This pool is currently 15m to 20m deep, and numerous large speleothems, particularly pillars, are submerged. A smaller pool, having a smaller range of fluctuation,[2] occurs in the Third Chamber, and, although the latter pool has been known to disappear, both bodies are thought to relate to the regional water table. A further permanent pool, maintaining a constant level, is the sump at the eastern end of The Rift. Recent exploration[3] has indicated that it is a perched pool as it receives a constant inflow below the surface, and maintains a

1. Gamble, W, pers. comm.
2. Gamble, W. pers. comm.
3. Maxwell, C.W., unpublished report, 1975

constant outflow over a cemented boulder barrier at its eastern end (Fig.4.5).

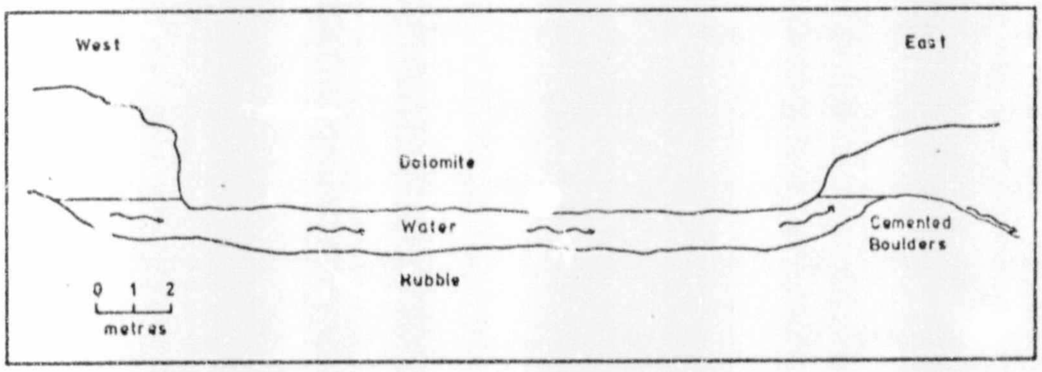

Figure 4.5: Schematic long section of the Sump in The Rift.

Numerous temporary pools occur on flowstone surfaces throughout the cave, water being supplied only by meteoric water dripping from the ceiling. More significant than these is the Sarcophagus Pool (see Fig.4.1) which is a temporary pool perched on a floor of boulders cemented with calcite. This pool was fed by streams issuing from the rockpile at the eastern end of the Second Chamber during and after the exceptionally wet 1974-1975 rains. These streams linked and flowed down the southern edge of the passage over a flowstone floor. The pool had an active outlet at its north-western corner, the water disappearing into the rockpile after flowing over a low lip. An active stream was also noted in the period February to April, 1975, in the western end of the Second Chamber, feeding into a large permanent rimstone pool on the southern wall. All of the streams observed within the cave during the course of this study are not permanent features of the cave, as their existence has not been reported previously, and they are probably related to the extremely high rainfall of the preceding wet season.

CORROSIONAL FORMS

Corrosional forms are those which generally occur on the walls, ceiling or floor of a cave, and which owe their form to the solutional processes operating during and after the development of the system. A large number of such features have been described by Bretz (1942), Howard (1964) and others, but only the following may be observed in the Wolkberg Cave.

Joint controlled networks

Minor joint controlled networks exist in the south-western wall of the Third Chamber, the northern wall of The Rift, and the southern wall of the First Chamber. Typically, they consist of a series of enlarged joint-cavities, there being two perpendicular sets intersecting at intervals of between 1m and 3m. Many of the joint cavities contain a dark chocolate brown clay fill, samples of which are highly saturated with water. The walls of the series in the northern side of The Rift are liberally coated with re-dissolved speleothems, and a number of the cavities contain a dark cemented mud.

Avens

A number of minor avens may be observed within the Long

Passage. However, the major domed cavity of this type rises above the general ceiling level close to the southern wall of the Third Chamber. This aven is 10m in diameter, rising an estimated 15m above the ceiling level, and cemented breccia remnants occur close to its base. The aven has been recently modified by breakdown, as a small mound of breakdown debris occurs below it, and a large block, 2m by 3m by 5m, is cemented above the breccia remnants. The walls of the aven are well decorated with re-dissolved speleothems.

Corroded fractures

Fractures which display rounded corners and an enlarged section perpendicular to the ceiling or walls occur frequently throughout the cave. The most obvious of these can be followed continuously in the ceiling of The Rift west of the sump for 100m.

Boxwork and preferential etching of dolomite

Boxworks, comprising thin calcite sheets exposed by the etching out of intervening dolomite, may be observed in the proximity of the sump in The Rift. Typically, the dimensions of the boxes are 100mm by 100mm, being terminated vertically by chert bands, and the calcite sheets protruding from the dolomite by only 5mm to 10mm.

More commonly, it may be observed that chert bands are preferentially exposed by the etching out of dolomite without the vertical boxing of calcite filled joints. In these cases, the chert may protrude up to 100mm from the dolomite, and is badly leached, frequently crumbling to the touch. Such exposures are common throughout the Long Passage and The Rift, particularly on the southern wall.

Re-solution of speleothems and fill materials

Speleothems which show marked signs of re-solution are common throughout the cave, the primary effects being the smoothing and dulling of surfaces, and etching of shawls. The solid fill materials also commonly display the influence of re-solution or leaching, breakdown blocks having extremely brittle chert bands and rounding of angular corners, and cemented breccia deposits frequently occurring as scalloped remnants below re-dissolved flowstone carapaces.

FILLS

Speleothems

Calcium carbonate speleothems are abundant throughout the system, the greatest densities occurring in the First and Second Chambers. The range of types of speleothems present is high (Table 4.2), as is the variation in size. A variation in the age of speleothems is apparent, based on the size, appearance and influence of re-solution on them. At least three phases of speleothem growth separated by periods of re-solution can be

TABLE 4.2: Speleothems; features and occurrence.

Feature	First Chamber	Second Chamber	Long Passage	Third Chamber	The Rift	Vertical Passage	Boulder Chamber
Stalactites	x	x	x	x	x		x
Stalagmites	x	x	x	x	x		x
Shawls	x	x	x		x		x
Pillars	x	x	x				
Nodules	x	x					
Needles	x	x					x
Straws		x	x				x
Helictites		x	x				x
Flowstone	x	x	x	x	x		x
Carapaces	x	x	x	x	x		
Re-solution	x	x	x	x	x		x
Water marks		x					
Earth burial	x						
Soil stains	x	x					

recognised in the First Chamber, the earliest phases being represented by a heavily re-dissolved veneer of flowstone on the walls and ceiling of the chamber. The middle phase is indicated by massive speleothems, predominantly in the form of pillars, scattered throughout the chamber, and also shawls and stalactities attached to the earlier veneer. All of these speleothems of the second phase show the effects of re-solution as their surfaces are bleached and smoothed, although the major form is retained. The youngest phase of speleothem growth is indicated by a veneer of either nodular or random oriented needle growths on the surface of the middle phase decoration in particular. The youngest phase shows no evidence of re-solution, but it is apparent that there may have been some periodicity in the deposition of calcium carbonate as a number of levels of flowstone development are related to these speleothems.

A sequence of speleothem growth similar to that of the First Chamber may be noted elsewhere in the cave, although the specific indicators vary. The assemblage frequently includes only representatives of the middle and youngest phases of growth, although the former may often be seen to have developed in two stages. The youngest phase is typically indicated by straws, helictities and small stalactities, most of which are currently active, and the middle phase by re-dissolved stalactites, stalagmites and shawls.

Talma, Vogel and Partridge (1974) have conducted analyses of the mineral content and the ages of speleothems from the Wolkberg Cave, concluding that three phases of calcium carbonate deposition have occurred, separated by two major phases of re-solution. They further comment that samples taken from the more massive speleothems may be composed of either calcite or aragonite, but that the more recent speleothems consist mainly of aragonite. The age determinations conducted by Talma and his co-authors indicate a variation in the age of speleothems, ranging from greater than 45 000 years B.P. to the present, a major phase of re-solution having occurred between 29 560 years B.P. and 3 390 years B.P., and a further re-solution phase having occurred prior to 43 200 years B.P. The dates obtained for re-solution phases by these workers should be treated with caution, however, since each refers to an age determination conducted on a single sample. Furthermore, the sample giving information on the younger of the phases was collected from the rock pile in the Second Chamber [illegible]h is approximately 25m above the point from which a sample giving an age of 19 800 years B.P. was obtained.

Indirect evidence of phases of deposition interspersed by solution may be obtained from the flowstone carapaces which occur throughout the cave. Two types of carapace may be distinguished, the more prominent being those capping breccia remnants, and the second form being minor flowstone carapace remnants preserved on pillars in the First Chamber. The former type of carapace, in particular, is indicative of phases of deposition and re-solution, since the sequence of breccias indicates that phases of solution have occurred, as each breccia has been re-dissolved and partially re-worked before emplacement of the next youngest breccia. A more recent inundation of the cave may be inferred from the water marks preserved on pillars and walls in the Second Chamber, although there is little re-solution associated with these indicators.

Burial of speleothems by earth fills has occurred in the First Chamber, particularly in the extreme eastern portion of the chamber where a soil fill line is evident on the wall, and stalactites show evidence of burial. More prominent is the burial of stalagmites, flowstone and shawls along the northern wall of the chamber where a sequence of alternating calcium carbonate deposition and earth burial may be ascertained.

R[illegible]re and collapse products

[illegible] occurrence of angular collapse blocks is ubiqu[illegible] throughout the cave. The dimensions of the blocks range from rare specimens 10m by 10m by 5m to pebble-sized material, the most common size being of the order of 100mm by 300mm square. The major collapse mounds occupy the whole of the First Chamber and the eastern end of the Second Chamber, with minor collapse domes occurring in the Long Passage and at the eastern end of The Rift.

The mound of collapse material in the First Chamber is an elongate structure with two levels, the first relating to the general roof level, and the second, higher, level being related to the higher dome of the entrance. This mound is continuous down through the Vertical Passage, the steep descent into the Boulder Chamber being accomplished through rockpile held against a solid wall, and is also continuous beneath a flowstone cover into the Second Chamber. The breakdown mound of the Second Chamber has a similar form to that of the First Chamber, that is, an elongate mound with a relatively flat top, but occurs at a lower level in the system. The Third Chamber is anomalous with respect to collapse fill since it shows evidence of enlargement by collapse, but has no mound of collapse material, having only a thin veneer of collapse blocks close to the northern wall and its eastern end, at the start of The Rift.

Earth fills of internal origin

Earth fills having an internal origin are rare in the Wolkberg system (Table 4.3). Typically, such deposits are composed of extremely fine silica grains which are stained orange, and the area covered by such deposits is small. The deposit in the Long Passage occurs on a slope, and is associated with a large amount of decomposing chert, indicating that such fill material may be the end product of chert breakdown.